

## CLAIMS

What is claimed is:

1. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

a wave parameter estimator connected to the input of the audio processor and comprising at least a first analysis filter connected to at least a first microphone, wherein the at least a first analysis filter creates an input signal in addition to the input signals characterizing the wave and wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter filters the input signals according to the at least a first gain.

2. The audio processor as defined in claim 1, wherein the at least a first analysis filter performs differentiation with respect to time.

3. The audio processor as defined in claim 2, wherein the at least a first analysis filter uses a difference equation to approximate differentiation with respect to time.

4. The audio processor as defined in claim 1, wherein the wave parameter estimator further comprises at least a second analysis filter connected to the at least a first microphone.

5. The audio processor as defined in claim 1, wherein the wave parameter estimator further comprises at least a second analysis filter connected to at least a second microphone.

6. The audio processor as defined in claim 1, wherein the wave parameter estimator operates in the frequency domain.

7. The audio processor as defined in claim 1, wherein the wave parameter estimator operates in the time domain.

8. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

a wave parameter estimator connected to the input of the audio processor and comprising an equation solver performing a direct solving technique, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a

first set of wave parameter estimates, wherein the forward filter filters the input signals according to the at least a first gain.

9. An audio processor for a sound processing system comprising two microphones  
5 and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

10 a wave parameter estimator connected to the input of the audio processor and comprising an equation solver performing an iteration technique, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

15 a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter filters the input signals according to the at least a first gain.

10. An audio processor for a sound processing system comprising two microphones  
20 and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

a wave parameter estimator connected to the input of the audio processor and comprising an equation solver performing a parameter scan technique, wherein the wave parameter estimator

generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for  
5 generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter filters the input signals according to the at least a first gain.

10 11. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

15 a wave parameter estimator connected to the input of the audio processor and comprising an equation solver performing a solution screening/optimizing for minimal power technique, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

20 a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter filters the input signals according to the at least a first gain.

12. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

5 a wave parameter estimator connected to the input of the audio processor and comprising an equation solver employing a look up table containing pre-computed solutions, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

10 a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter filters the input signals according to the at least a first gain.

15 13. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

20 a microphone equalizer connected to the input of the audio processor, wherein at least one of the signals from the microphones that characterize the wave are filtered with an equalization filter; and

an apparent incidence processor connected to the output of the microphone equalizer, the apparent incidence processor comprising:

a wave parameter estimator connected to the input of the apparent incidence processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

5 a forward filter connected both to the input of the apparent incidence processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter filters the input signals according to the at least a first gain.

10 14. The audio processor as defined in claim 13, wherein the equalization filter comprises a dynamic part.

15 15. The audio processor as defined in claim 14, wherein the equalization filter further comprises a forgetting factor.

20 16. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

a wave parameter estimator connected to the input of the audio processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, the forward filter further includes a statistical evaluator that  
5 analyzes the at least a first set of wave parameter estimates in the at least a first frequency band to generate at least one output signal that is input to the forward filter gain controller, wherein the at least one output signal is based on at least one weight that is applied to a wave energy measure and the weighted wave energy measure is low pass filtered.

10 17. The audio processor as defined in claim 16, wherein the at least one weight is based on a difference between a measured direction of sound incidence and a target direction of sound incidence.

15 18. The audio processor as defined in claim 16, wherein the at least one weight is based on a measured wave damping.

19. The audio processor as defined in claim 16, wherein the statistical evaluator generates estimates for a noise power of the sound field in the at least a first frequency band.

20 20. The audio processor as defined in claim 16, wherein the statistical evaluator generates estimates for a utility signal power of the sound field in the at least a first frequency band.

21. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

5 a wave parameter estimator connected to the input of the audio processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

10 a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a look up table containing at least a first predetermined gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter filters the input signals according to the at least a first gain.

15 22. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

20 a wave parameter estimator connected to the input of the audio processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

a first forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the first forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at



least a first set of wave parameter estimates, wherein the first forward filter filters the input signals according to the at least a first gain; and

a second forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the second forward filter includes a forward filter gain controller for generating at least a second gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the second forward filter filters the input signals according to the at least a second gain.

23. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

an analog beamformer connected to the input of the audio processor, wherein the signals from the microphones that characterize the wave are preprocessed;

at least two analog to digital converters having different resolutions that are connected to the output of the analog beamformer; and

an apparent incidence processor connected to the output of the at least two analog to digital converters, the apparent incidence processor comprising:

a wave parameter estimator connected to the input of the apparent incidence processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the apparent incidence processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter filters the input signals according to the at least a first gain.

24. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

an analysis beamformer connected to the input of the audio processor, wherein the signals from the microphones that characterize the wave are combined using at least one filter;

a wave parameter estimator connected to the output of the analysis beamformer, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter filters the input signals according to the at least a first gain.

25. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency

band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

a wave parameter estimator connected to the input of the audio processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward beamformer for filtering the input signals and a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter filters the beamformed input signals according to the at least a first gain.

26. The audio processor as defined in claim 25, wherein the forward beamformer includes at least one adaptive beamformer.

27. The audio processor as defined in claim 26, wherein the at least a gain generated by the forward filter gain controller is a function of the rate of change of at least one adaptive beamformer coefficient.

28. The audio processor as defined in claim 26, wherein the adaptive beamforming is achieved by generating a target beam signal and one or more rear beam signals, wherein the target beam signal has non-zero sensitivity towards a target direction and the one or more rear

beam signals are a number of different beam signals that all have substantially zero sensitivity towards the target direction.

29. The audio processor as defined in claim 28, wherein the one or more rear beam  
5 signals are filtered and the filter responses used to filter the one or more rear beam signals are adapted by adaptors.

30. The audio processor as defined in claim 26, wherein the forward filter gain  
controller compensates the at least a first gain for any directional characteristics of the forward  
10 beamformer.

31. The audio processor as defined in claim 25, wherein the forward beamformer  
includes at least one static beamformer and at least one adaptive beamformer.

32. An audio processor for a sound processing system comprising at least three  
15 microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

a wave parameter estimator connected to the input of the audio processor, wherein the  
20 wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave from the at least three microphones; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter filters the input signals according to the at least a first gain.

33. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

a wave parameter estimator connected to the input of the audio processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, the forward filter further includes a gain smoother connected to the output of the forward filter gain controller for preventing the occurrence of abrupt gain changes, wherein the forward filter filters the input signals according to the at least a first gain.

34. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency

band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

a wave parameter estimator connected to the input of the audio processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter gain controller compares at least one wave parameter estimate from the at least a first set of wave parameter estimates to a predetermined threshold value and the forward filter filters the input signals according to the at least a first gain.

35. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

a wave parameter estimator connected to the input of the audio processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a

first set of wave parameter estimates including a wave direction parameter estimate, wherein the forward filter filters the input signals according to the at least a first gain.

36. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

a wave parameter estimator connected to the input of the audio processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates including a wave damping parameter estimate, wherein the forward filter filters the input signals according to the at least a first gain.

37. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

a wave parameter estimator connected to the input of the audio processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter gain controller comprises a strategy chooser for selecting an overall gain strategy and the forward filter filters the input signals according to the at least a first gain.

38. The audio processor as defined in claim 37, wherein the overall gain strategy is based on a power measurement.

39. The audio processor as defined in claim 38, wherein the strategy chooser implements both an omni directional gain strategy and a directional gain strategy selected by comparing a wideband signal power with a wideband noise power, wherein the omni directional strategy is active in all narrow frequency bands covered by wide bands where signal power is greater than a predefined constant times the noise power and in all other bands, the directional strategy is active.

40. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:



a wave parameter estimator connected to the input of the audio processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter gain controller comprises a gain function applier for controlling the gain for the at least one wave and the forward filter filters the input signals according to the at least a first gain.

41. The audio processor as defined in claim 40, wherein the gain function applier operates by comparing the direction of incidence with a target direction such that when the direction of incidence is within a predefined tolerance from the target direction, then the gain is set to a predefined maximal gain and otherwise the gain is set to a predefined minimal gain.

42. The audio processor as defined in claim 40, wherein the gain function applier controls the gain so as to attenuate waves where the absolute value of the wave damping is greater than a predefined threshold.

43. The audio processor as defined in claim 40, wherein the gain function applier controls the gain so as to attenuate waves where the value of the wave damping is lower than a predefined threshold.

44. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

5 a wave parameter estimator connected to the input of the audio processor, wherein the wave parameter estimator generates at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave and the wave parameter estimator disregards the amplitude information of the input signals during the generation of a wave direction estimate; and

10 a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, the forward filter includes a forward filter gain controller for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates, wherein the forward filter filters the input signals according to the at least a first gain.

15 45. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

20 a wave parameter estimator connected to the input of the audio processor and comprising an equation solver employing a look up table containing pre-computed solutions for wave gains, wherein the wave parameter estimator generates at least a first wave gain for the at least a first frequency band of the input signals characterizing the wave; and

a forward filter connected both to the input of the audio processor and to the output of the wave parameter estimator, wherein the forward filter filters the input signals according to the at least a first wave gain.

5           46.     A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

10                 creating at least a first analysis filter input signal in addition to the input signals  
characterizing the wave;  
                   generating at least a first set of wave parameter estimates for the at least a first frequency  
band of the input signals;  
                   generating at least a first gain for the at least a first frequency band as a function of the at  
least a first set of wave parameter estimates; and  
15                 filtering the input signals according to the at least a first gain.

              47.     The method as defined in claim 46, wherein the at least a first analysis filter input signal is created through differentiation with respect to time.

20           48.     The method as defined in claim 47, wherein the differentiation with respect to time is approximated using a difference equation.

49. The method as defined in claim 46, wherein one of the first set of wave parameter estimates is a wave frequency estimate.

50. The method as defined in claim 46, wherein one of the first set of wave parameter  
5 estimates is a wave amplitude estimate.

51. The method as defined in claim 46, wherein one of the first set of wave parameter estimates is a direction of sound incidence estimate for the wave.

10 52. The method as defined in claim 46, wherein one of the first set of wave parameter estimates is a wave damping estimate.

53. The method as defined in claim 46, wherein generating at least a first set of wave  
parameter estimates is performed in the frequency domain.

15 54. The method as defined in claim 46, wherein generating at least a first set of wave parameter estimates is performed in the time domain.

55. A method of audio signal processing for a system comprising two microphones  
20 and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave through the use of a direct solving technique;

generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

5 filtering the input signals according to the at least a first gain.

56. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

10 generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave through the use of an iteration technique;

generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

15 filtering the input signals according to the at least a first gain.

57. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

20 generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave through the use of a parameter scan technique;

generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

filtering the input signals according to the at least a first gain.

5           58.     A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

10           generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave through the use of a solution screening/optimizing for minimal power technique;

15           generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

20           filtering the input signals according to the at least a first gain.

25           59.     A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

30           generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave through the use of a look up table containing pre-computed solutions;

generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

filtering the input signals according to the at least a first gain.

5           60.     A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

10           equalization filtering at least one of the signals, from the microphones, that characterize the wave;

15           generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals;

20           generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

25           filtering the input signals according to the at least a first gain.

30           61.     The method as defined in claim 60, wherein equalization filtering comprises the use of a filter response that is dynamically updated.

35           62.     The method as defined in claim 61, wherein dynamically updating the filter response comprises a forgetting factor.

63. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

5 generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

low pass filtering the at least a first set of wave parameter estimates in the at least a first frequency band to generate at least one low pass filtered signal;

generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates and the at least one low pass filtered signal; and

10 filtering the input signals according to the at least a first gain.

64. The method as defined in claim 63, wherein one of the at least a first set of wave parameter estimates is a wave power estimate that is low pass filtered.

15 65. The method as defined in claim 64, further comprising weighing the wave power estimate before low pass filtering.

20 66. The method as defined in claim 65, wherein weighing is based on a difference between a measured direction of sound incidence and a target direction of sound incidence.

67. The method as defined in claim 65, wherein weighing is based on a measured wave damping.



68. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

5 generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

generating at least a first gain by employing a look up table containing at least a first predetermined gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

10 filtering the input signals according to the at least a first gain.

69. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

15 generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals that characterize the wave;

generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates;

20 generating at least a second gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates;

filtering the input signals according to the at least a first gain; and

filtering the input signals according to the at least a second gain.

70. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method  
5 comprising:

preprocessing the signals, from the at least two microphones, that characterize the wave to obtain two sets of preprocessed signals;

converting the first set of preprocessed signals from analog to digital using high resolution;

10 converting the second set of preprocessed signals from analog to digital using low resolution;

generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals;

generating at least a first gain for the at least a first frequency band as a function of the at  
15 least a first set of wave parameter estimates; and

filtering the input signals according to the at least a first gain.

71. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency  
20 band and the sound environment has a wave with at least a first wave parameter, the method comprising:

beamforming the signals, from the microphones, that characterize the wave;

generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals;

generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

5 filtering the input signals according to the at least a first gain.

72. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

10 generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

filtering through a beamformer the input signals;

15 generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

filtering the beamformed input signals according to the at least a first gain.

73. The method as defined in claim 72, wherein the beamformer includes at least one adaptive beamformer.

20 74. The method as defined in claim 73, wherein the adaptive beamforming is achieved by generating a target beam signal and one or more rear beam signals, wherein the target beam signal has non-zero sensitivity towards a target direction and the one or more rear

beam signals are a number of different beam signals that all have substantially zero sensitivity towards the target direction.

75. The method as defined in claim 74, wherein the one or more rear beam signals are filtered and the filter responses used to filter the one or more rear beam signals are adapted to minimize the beamformer output power.

76. The method as defined in claim 72, further comprises compensating the at least a first gain for any directional characteristics of the beamformer.

77. A method of audio signal processing for a system comprising at least three microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave from the at least three microphones;

generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

filtering the input signals according to the at least a first gain.

78. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency

band and the sound environment has a wave with at least a first wave parameter, the method comprising:

generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

5 generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates;

smoothing the gain to prevent the occurrence of abrupt gain changes; and

filtering the input signals according to the at least a first gain.

10 79. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

15 generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

comparing at least one wave parameter estimate from the at least a first set of wave parameter estimates to a predetermined threshold value;

generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates and the comparison; and

20 filtering the input signals according to the at least a first gain.

80. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency

band and the sound environment has a wave with at least a first wave parameter, the method comprising:

generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

5 generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates including a wave direction parameter estimate; and  
filtering the input signals according to the at least a first gain.

10 81. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

15 generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates including a wave damping parameter estimate; and  
filtering the input signals according to the at least a first gain.

20 82. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

selecting an overall gain strategy;

generating at least a first gain for the at least a first frequency band as a function of the at

5 least a first set of wave parameter estimates and the selected gain strategy; and

filtering the input signals according to the at least a first gain.

83. The method as defined in claim 82, wherein selecting the overall gain strategy is based on a power measurement.

10 84. The method as defined in claim 83, wherein the overall gain strategy comprises both an omni directional gain strategy and a directional gain strategy selected by comparing a wideband signal power with a wideband noise power, wherein the omni directional strategy is active in all narrow frequency bands covered by wide bands where signal power is greater than a  
15 predefined constant times the noise power and in all other bands, the directional strategy is active.

85. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency  
20 band and the sound environment has a wave with at least a first wave parameter, the method comprising:

generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates by selecting the at least a first gain from a finite set of predefined gain values; and

filtering the input signals according to the at least a first gain.

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86. The method as defined in claim 85, wherein one wave parameter of the at least a first set of wave parameter estimates is a direction of incidence parameter and selecting comprises comparing the direction of incidence with a target direction such that when the direction of incidence is within a predefined tolerance from the target direction, then the gain is set to a predefined maximal gain and otherwise the gain is set to a predefined minimal gain.

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87. The method as defined in claim 85, wherein the at least a first gain is generated so as to attenuate waves where the absolute value of the wave damping is greater than a predefined threshold.

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88. The method as defined in claim 85, wherein the at least a first gain is generated so as to attenuate waves where the value of the wave damping is lower than a predefined threshold.

89. A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

20



generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave, wherein the at least a first set of wave parameter estimates includes a wave direction estimate that disregards the amplitude information of the input signals;

5       generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

filtering the input signals according to the at least a first gain.

10       90.     A method of audio signal processing for a system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the method comprising:

15       generating at least a first wave gain for the at least a first frequency band of the input signals characterizing the wave by employing a look up table containing pre-computed solutions for wave gains; and

filtering the input signals according to the at least a first wave gain.

20       91.     An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for creating at least a first analysis filter input signal in addition to the input signals characterizing the wave;

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals;

means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

5 means for filtering the input signals according to the at least a first gain.

92. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

10 means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave through the use of a direct solving technique;

15 means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

means for filtering the input signals according to the at least a first gain.

93. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave through the use of an iteration technique;

means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

means for filtering the input signals according to the at least a first gain.

94. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave through the use of a parameter scan technique;

means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

means for filtering the input signals according to the at least a first gain.

95. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave through the use of a solution screening/optimizing for minimal power technique;

means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

means for filtering the input signals according to the at least a first gain.

96. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave through the use of a look up table containing pre-computed solutions;

means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

means for filtering the input signals according to the at least a first gain.

97. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for equalization filtering at least one of the signals, from the microphones, that characterize the wave;

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals;

5 means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

means for filtering the input signals according to the at least a first gain.

98. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

15 means for low pass filtering the at least a first set of wave parameter estimates in the at least a first frequency band to generate at least one low pass filtered signal;

means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates and the at least one low pass filtered signal; and

20 means for filtering the input signals according to the at least a first gain.

99. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency

band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

5 means for generating at least a first gain by employing a look up table containing at least a first predetermined gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

means for filtering the input signals according to the at least a first gain.

100. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals that characterize the wave;

means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates;

means for generating at least a second gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates;

means for filtering the input signals according to the at least a first gain; and

means for filtering the input signals according to the at least a second gain.

101. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

5 means for preprocessing the signals, from the at least two microphones, that characterize the wave to obtain two sets of preprocessed signals;

means for converting the first set of preprocessed signals from analog to digital using high resolution;

10 means for converting the second set of preprocessed signals from analog to digital using low resolution;

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals;

15 means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

means for filtering the input signals according to the at least a first gain.

20 102. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for beamforming the signals, from the microphones, that characterize the wave;

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals;

means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

means for filtering the input signals according to the at least a first gain.

5           103. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

10               means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

              means for filtering through a beamformer the input signals;

              means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

              means for filtering the beamformed input signals according to the at least a first gain.

15           104. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

20               means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave from the at least three microphones;

              means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and



means for filtering the input signals according to the at least a first gain.

105. An audio processor for a sound processing system comprising two microphones  
and an output device, wherein the system senses a sound environment in at least a first frequency  
5 band and the sound environment has a wave with at least a first wave parameter, the audio  
processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first  
frequency band of the input signals characterizing the wave;

10 means for generating at least a first gain for the at least a first frequency band as a  
function of the at least a first set of wave parameter estimates;

means for smoothing the gain to prevent the occurrence of abrupt gain changes; and

means for filtering the input signals according to the at least a first gain.

106. An audio processor for a sound processing system comprising two microphones  
15 and an output device, wherein the system senses a sound environment in at least a first frequency  
band and the sound environment has a wave with at least a first wave parameter, the audio  
processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first  
frequency band of the input signals characterizing the wave;

20 means for comparing at least one wave parameter estimate from the at least a first set of  
wave parameter estimates to a predetermined threshold value;

means for generating at least a first gain for the at least a first frequency band as a  
function of the at least a first set of wave parameter estimates and the comparison; and

means for filtering the input signals according to the at least a first gain.

107. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates including a wave direction parameter estimate; and

means for filtering the input signals according to the at least a first gain.

108. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates including a wave damping parameter estimate; and

means for filtering the input signals according to the at least a first gain.

109. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio  
5 processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

means for selecting an overall gain strategy;

means for generating at least a first gain for the at least a first frequency band as a  
10 function of the at least a first set of wave parameter estimates and the selected gain strategy; and  
means for filtering the input signals according to the at least a first gain.

110. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency  
15 band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave;

means for generating at least a first gain for the at least a first frequency band as a  
20 function of the at least a first set of wave parameter estimates by selecting the at least a first gain from a finite set of predefined gain values; and

means for filtering the input signals according to the at least a first gain.

111. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

5 means for generating at least a first set of wave parameter estimates for the at least a first frequency band of the input signals characterizing the wave, wherein the at least a first set of wave parameter estimates includes a wave direction estimate that disregards the amplitude information of the input signals;

10 means for generating at least a first gain for the at least a first frequency band as a function of the at least a first set of wave parameter estimates; and

means for filtering the input signals according to the at least a first gain.

112. An audio processor for a sound processing system comprising two microphones and an output device, wherein the system senses a sound environment in at least a first frequency band and the sound environment has a wave with at least a first wave parameter, the audio processor comprising:

15 means for generating at least a first wave gain for the at least a first frequency band of the input signals characterizing the wave by employing a look up table containing pre-computed solutions for wave gains; and

20 means for filtering the input signals according to the at least a first wave gain.